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Standard Guide for Computed Tomography (CT) Imaging[1]

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This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 Computed tomography (CT) is a radiographic method that provides an ideal examination technique whenever the primary goal is to locate and size planar and volumetric detail in three dimensions. Because of the relatively good penetrability of X-rays, as well as the sensitivity of absorption cross sections to atomic chemistry, CT permits the nondestructive physical and, to a limited extent, chemical characterization of the internal structure of materials. Also, since the method is X-ray based, it applies equally well to metallic and nonmetallic specimens, solid and fibrous materials, and smooth and irregularly surfaced objects. When used in conjunction with other nondestructive evaluation (NDE) methods, such as ultrasound, CT data can provide evaluations of material integrity that cannot currently be provided nondestructively by any other means.

1.2 This guide is intended to satisfy two general needs for users of industrial CT equipment: (*1*) the need for a tutorial guide addressing the general principles of X-ray CT as they apply to industrial imaging; and (*2*) the need for a consistent set of CT performance parameter definitions, including how these performance parameters relate to CT system specifications. Potential users and buyers, as well as experienced CT inspectors, will find this guide a useful source of information for determining the suitability of CT for particular examination problems, for predicting CT system performance in new situations, and for developing and prescribing new scan procedures.

1.3 This guide does not specify test objects and test procedures for comparing the relative performance of different CT systems; nor does it treat CT inspection techniques, such as the best selection of scan parameters, the preferred implementation of scan procedures, the analysis of image data to extract densitometric information, or the establishment of accept/reject criteria for a new object.

1.4 Standard practices and methods are not within the purview of this guide. The reader is advised, however, that examination practices are generally part and application specific, and industrial CT usage is new enough that in many instances a consensus has not yet emerged. The situation is complicated further by the fact that CT system hardware and performance capabilities are still undergoing significant evolution and improvement. Consequently, an attempt to address generic examination procedures is eschewed in favor of providing a thorough treatment of the principles by which examination methods can be developed or existing ones revised.

1.5 The principal advantage of CT is that it nondestructively provides quantitative densitometric (that is, density and geometry) images of thin cross sections through an object. Because of the absence of structural noise from detail outside the thin plane of inspection, images are much easier to interpret than conventional radiographic data. The new user can learn quickly (often upon first exposure to the technology) to read CT data because the images correspond more closely to the way the human mind visualizes three-dimensional structures than conventional projection radiography. Further, because CT images are digital, they may be enhanced, analyzed, compressed, archived, input as data into performance calculations, compared with digital data from other NDE modalities, or transmitted to other locations for remote viewing. Additionally, CT images exhibit enhanced contrast discrimination over compact areas larger than 20 to 25 pixels. This capability has no classical analog. Contrast discrimination of better than 0.1 % at three-sigma confidence levels over areas as small as one-fifth of one percent the size of the object of interest are common.

1.6 With proper calibration, dimensional inspections and absolute density determinations can also be made very accurately. Dimensionally, virtually all CT systems provide a pixel resolution of roughly 1 part in 1000 , and metrological algorithms can often measure dimensions to one-tenth of one pixel or so with three-sigma accuracies. For small objects (less than 100 mm (4 in.) in diameter), this translates into accuracies of approximately 0.1 mm (0.003 to 0.005 in.) at three-sigma. For much larger objects, the corresponding figure will be proportionally greater. Attenuation values can also be related accurately to material densities. If details in the image are

[1] This guide is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.01 on Radiology (X and Gamma) Method.

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***A Summary of Changes section appears at the end of this standard**

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